JOSEPH DALTON HOOKER, F.R.S.

PIONEERS OF PROGRESS

MEN OF SCIENCE

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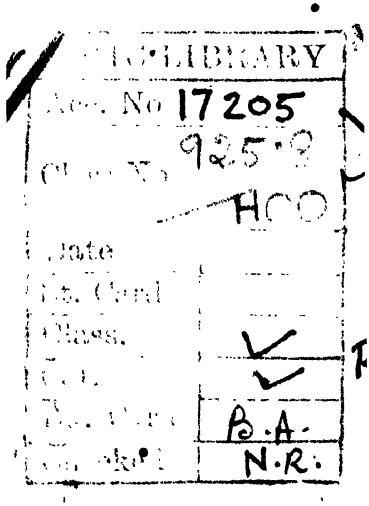

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CHAPTER I.

HISTORICAL INTRODUCTION.

SIR JOSEPH HOOKER was by general consent held to be the leading botanist of his age. That age witnessed the greatest revolution of all time in biological thought. It was the period when evolution was born, and Hooker assisted at the birth. It was then that the belief in fixity of species was shaken, and finally overthrown: in its place came a belief in the mutability of species, and the genesis of new forms. The change touched religious and philosophical thought profoundly, and has led to a wholly altered outlook on life. By right therefore Sir Joseph Hooker takes his place among the "Pioneers of Progress". He should stand in history at the right hand of Darwin, as he actually did in fact throughout the period while the *Origin of Species* was in preparation. But before the story of his life is told, a brief historical sketch may help the reader to understand the part which he played in the great drama.

The ancient science of botany concerned itself in the first instance with the recognition and description of different kinds of plants. Naturally precedence was given to those which were of use to man. Consequently from classical times up to the middle of the seventeenth century books on the subject were largely of the nature of herbals, or catalogues of the plants described, with their uses. They were often elaborately illustrated, as is seen in the best examples of the sixteenth and seventeenth centuries. A growing sense of affinity, or kinship of

like forms led to a natural grouping of plants. At first it was by instinctive feeling that the affinity was perceived, rather than by reference to characters strictly analysed or defined. The methods of grouping became gradually more precise, and crystallised out into the early systems of classification. Unfortunately at first use was made of only a few easily recognised marks, which were determined arbitrarily. This was the inherent weakness of the system of Linnæus, which was the culmination of these early efforts. However effective that system might be for the recognition and naming of plants, it, with others of like nature, has been justly called "artificial," since plants that were not really akin were thereby brought into relation. Linnæus himself was aware of the imperfection of his scheme, and took steps towards its improvement. But it fell to de Jussieu and de Candolle so to widen the use of the characters selected as the basis of classification that a more real affinity of the plants became apparent. The Natural System thus founded has been extended, with ever more searching analysis of the marks and characters used, up to the present time.

Upon the recognition and definition of species there followed hard the assumption of their constancy. This doctrine appeared in an unobtrusive form in the writings of Linnaeus himself. It was the result of his daily experience in the analysis of specific differences with a view to classification. But with his successors it became an article of faith, stated dogmatically. It was held that each organic form owed its existence to a separate act of creation, and was therefore distinct from all other forms. Species were thus viewed as isolated phenomena which illustrated the ability of the Creator, rather than as having any nearer causal relation. The very likeness which members of a family show was held to exhibit ingenious variation upon a divine plan of construction. To suggest any doubt of this became sacrilege, a wilful

derogation of divine power. But on the other hand there was the growing sense of kinship of living things. Close comparison led to a convincing recognition of natural affinity. The further the observation of types was pursued the stronger the bonds of affinity appeared to be, and the greater the mystery of their resemblance. But the doctrine of the independent creation of constant species seems quite incompatible with any idea of affinity in the ordinary sense of the word. This must have made the outlook of the pre-Darwinian systematist highly unsatisfactory to any intelligent man. Well might Elias Fries remark in 1835, that there was *quoddam supernaturale* in the Natural System. Many of the best botanists of the early nineteenth century, however, were content to expend their labour upon the record and recognition of those "affinities" without raising the inconvenient question of causality.

Meanwhile plants were being examined from other points of view than that of external form. In the latter half of the seventeenth century the Royal Society was founded, and about the same time the compound microscope was invented. It was at once used to illuminate the internal structure of plants, and the earliest results were published in the "Philosophical Transactions". This opened a new chapter in the science, for close upon the heels of structural observation came enquiry into function. Anatomy and physiology henceforth advanced together like twin sisters, mutually assisting one another. During the seventeenth and eighteenth centuries Britain was in the forefront in the pursuit of these branches of botany: but at the time of Hooker's birth their cultivation had drifted away to the continent, to return only towards the close of his career. Nevertheless, during his busiest years he made notable additions to knowledge in both of these fields of research.

Increasing facilities for foreign travel led naturally as

time went on to wider opportunities for collecting, both in the interior of continents and on distant and isolated islands. The heroic period of travel with scientific objects in view opened with the voyages of Captain Cook. The private enterprise of Sir Joseph Banks, who sailed with Cook, ensured the scientific success of the first visits to Australia and New Zealand. Later there followed the series of expeditions of the early nineteenth century, which Darwin, Hooker, Huxley, Wallace, and Spruce have rendered famous. Not only were a multitude of new types of life discovered, but the foundations were laid for that new branch of learning, botanical geography, or the distribution of plants in space, in which Hooker became the acknowledged master.

Finally, the study of vegetation in respect of time was initiated early in that outburst of geological enquiry which marked the close of the eighteenth and the opening of the nineteenth centuries. Fossil plants were first studied as impressions: but later the microscope was directed to the structure of fossilised specimens, which were examined in sections like any modern plant. Thus that volume of positive knowledge of the plants of former epochs began to grow, which tallies so ill with the doctrine of separate creation, and points more and more directly to some evolutionary view as the data accumulate. Hooker himself made important contributions to this branch of botanical science.

It was into this arena of conflict between facts and dogmatic statements that Sir Joseph Hooker entered as a youth. His keen and incisive mind could not fail to note the inconsistencies. Though tradition and the opinion of his elders would naturally tend to smooth them over, his steadfast outlook would not be so satisfied. That it was not satisfied is shown by the story of his scientific life. He took a leading part in the fray, and lived long enough to see the dogma of the constancy of species refuted, and the mutability of

species fully established. But though the part he took in relation to the species question may be for the general public the most prominent feature of his scientific life, he made his mark among botanists in other ways. It will be shown how he took a leading position as a traveller, a collector, an administrator, and as a scientific systematist. His pre-eminent position among his contemporaries was the cumulative result of all these activities, pursued through an unusually long life, and continued to its very end.

CHAPTER II.

BIRTH AND EDUCATION.

SOME of the leaders of Science, like Faraday and Huxley, have won their way to the front by sheer ability, without early advantages or opportunities. Others have had their powers reinforced by favourable circumstances of early life. Sir Joseph Hooker was one of the latter. He was born within the hierarchy of Science. His maternal grandfather was Dawson Turner, F.R.S, a banker of Yarmouth, well known as an archæologist, a naturalist, and a writer on seaweeds. His grandfather Hooker was also a naturalist, collecting insects, and spending much of his time on the cultivation of rare plants. On both sides of the family there was a bias towards Natural History, combined with artistic leanings. But it was from his father that the most direct stimulus of example and of teaching came. He was Sir William Jackson Hooker, F.R.S., (1785-1865), for twenty years Regius Professor of Botany in the University of Glasgow, and afterwards Director, till his death, of the Royal Gardens at Kew. Not only did he thus hold leading positions as a teacher and administrator, but he was also a great collector, and one of the most prolific botanical writers of his day. His descriptive works covered a wide range. The published plates are estimated at over 8000, of which 1800 were drawn by himself. Notably his books on the Liverworts and the Ferns still hold their place as the foundation of critical knowledge of those groups. His herbarium and library now form the backbone of the

national establishment at Kew. He was a stately, handsome man, with a strong sense of duty, and austere religious views which put their check upon free speculative thought. Though socially disposed, he subordinated amusement to strenuous work. This gave a serious turn to the home, while the daily example set by the father of early rising and late work at night fixed a scale of conduct for the children.

Joseph, the second son, was born at Halesworth in Suffolk, on 30th June, 1817, and was brought to Glasgow, when his father took up the duties of the Chair of Botany there in 1820. From the first he seems to have been of a serious turn of mind: a child-collector, very observant, and with a retentive memory. As a boy his mother describes him as plodding, and without his elder brother's brilliancy. But on the other hand she tells how "Joseph bends all his soul and spirit to the task before him". This characteristic he retained throughout his long life. The conditions in Glasgow were most propitious for giving such a boy free scope to develop those faculties which he had inherited. In 1817, when doubtless the country was beginning to feel the rebound after the long Napoleonic wars, a botanic garden had been established in the outskirts of the town. Under the advantages yielded by a great port trading with all parts of the world, this newly-founded garden was growing in richness when the new professor arrived. It quickly became under his hands a notable centre for the reception and distribution of new and rare plants. It contained a lecture room where his college course was delivered. Lady Hooker describes how the boys aged respectively eight and seven accompanied their father in summer to his 8 a.m. lecture, returning at half past-nine to breakfast as hungry as young hawks. The professor had taken a house half-way between the garden and the old College in the High Street. There his rapidly-growing herbarium, museum, and library

were stored, and it was there that the drawings were constantly being made to illustrate that stream of descriptive works which Sir William was producing. New species must have been almost daily under examination, often as living specimens. Between the garden and the house the boy must have witnessed constantly, during the most receptive years of childhood, the working of an establishment that was at that time without its equal in this country, or probably in any other. The eye and the memory must have been trained almost unconciously. A wide knowledge of plants would be acquired as a natural consequence of the surroundings, and without the effort entailed by study in later years. Few ever have known plants, few ever will know them, as Hooker knew them. Such knowledge comes only from growing up with them from earliest childhood, as he did.

It was not only indoor work that was done in these early years. Glasgow was then as now within reach of beautiful open country. Sir William used to take his students for summer excursions, sometimes far up into the Highlands, and the boys went with the party. He acquired also a country home, first at Burnside, near Helensburgh, but later at Invereck on Loch Long. There in the summer they botanised, fished, sketched, and practised rough surveying, all a fit preparation for the adventurous years that were to follow.

Side by side with this less formal education the ordinary curriculum of school and college was pursued. The boys attended first at the High School of Glasgow. When Joseph was 15 he entered the University, finding himself there a contemporary with the late Lord Kelvin. Though much younger than most of his fellow-students he gained distinctions in Natural Philosophy and in Anatomy, and in 1836 he obtained a prize for the best essay on the Brain and Nerves. His medical course was completed early in 1839 when he graduated, and thus became qualified for employment in the Naval

Medical Service. An ambition to travel had long been developing in his mind, and it appears that his father had encouraged it. An incident of his student period, which he himself relates, gives an indication whence the inspiration sprang. He tells how an opportunity was afforded him of reading the proofs of Darwin's "Voyage of the Beagle". "I was hurrying on my studies (that is, for the final examination in Medicine), and so pressed for time was I that I used to sleep with the sheets of the *Journal* under my pillow, that I might read them between waking and rising. They impressed me profoundly, whilst they stimulated me to enthusiasm in the desire to travel and observe." The whole education of Hooker, with its gradually extending tours for practice in observation, had led up to this ambition. Trips to Arran and to Connemara accustomed him to rough life while studying the geology, botany, and entomology of the districts visited. He was already well-equipped as a collector, and the acquisition of a medical degree would make it possible to aspire to Government service. In 1838, after taking part in the meeting of the British Association in Newcastle, he proceeded to Haslar to be inspected by Dr. Richardson with a view to entering the naval service. This was with special reference to the forthcoming Antarctic voyage. It appears that Captain Ross, the commander of the expedition, had already seen Hooker at the house of Mr. Smith of Jordan Hill, and that his appointment was made contingent upon his passing the qualifying medical examination, which he did in May, 1839. The expedition sailed in September of that year, with Hooker as assistant surgeon in H.M.S. "Erebus". Seldom has education combined so happily with natural aptitude in preparing a young and active man for scientific travel. Seldom has the preparation proved so fully justified by the event.

CHAPTER III.

FOREIGN TRAVEL.

FOREIGN travel acts on the naturalist as though a fresh dimension of space were added to his outlook. Exclusive study in an over-cultivated and over-populated country such as Britain limits his scope. Until the world has been fully explored the opportunity for travel opens up ever fresh possibilities of discovery, and of widening views. Such considerations, together with the natural impulse of youth towards adventure, will always have their effect in luring young naturalists on to see some part of the great world, and to collect there. But prior knowledge is a necessary condition of success. If a definite problem be in view, following on special study, so much the better. Accordingly, care must be taken to select for scientific expeditions those best fitted for the work by education and by personal qualities.

At the end of the eighteenth and the beginning of the nineteenth centuries, the world was still very imperfectly known, while the means of access to its remote corners were steadily improving. At the same time those areas where science was rapidly developing had been over-run. What, then, could be more natural than that Joseph Hooker, whose education had been such as to mark him out as peculiarly fit for it, should long to explore and to collect? The immediate incentive was the record of Darwin's voyage in the "Beagle". If that book rouses us who read it now, what must have been its effect on a youth trained as young Hooker had been? His enthu-

siasm had its first opportunity of realisation in the four years' voyage to the Antarctic. Scientific exploration was still in its heroic age when Hooker sailed with Ross for the South. Darwin was only three years back from the voyage of the "Beagle". We may hold the years from 1831, when the "Beagle" sailed, to 1851, when Hooker returned from his Indian journey, or 1852, when Wallace returned from the Amazon, to have been its golden period. Certainly it was if we measure by results. Unmatched opportunity for travel in remote and unknown lands was then combined with unmatched capacity of those who engaged in it. Nor was this a matter of chance, for Darwin, Wallace, and Hooker all seized, if they did not in some measure make, their opportunity. Ross's expedition was in its way unique. Captain Scott, writing of it seventy years after its return, says that, when the extent of our knowledge before and after it is considered, all must concede that it deserves to rank among the most brilliant and famous that have been made.

Captain Ross sailed in September, 1839, in command of H.M.S. "Erebus" and "Terror". The length of the voyage was not defined; it was actually completed within four years. In three successive summers these two sailing ships entered the Antarctic ice. The very names of the Great Ice Barrier, McMurdo Sound, Mount Erebus, and Mount Terror, made familiar to us seventy years later under steam, remain to mark some of the additions then made to the map of the world. The prime object of the voyage was a magnetic survey, with special reference to the magnetic pole; and this determined its course, though the pole itself was never actually attained. Natural history was for the Government a secondary interest. But as Ross was himself an ardent naturalist, Hooker had the fullest scope given him. He tells how, when in harbour, his time was his own, to leave the ship as he liked, for the captain took

off all restrictions. His rambles were often solitary. Shipped as a surgeon and educated as a botanist, it might be thought that Hooker's opportunities when sailing frozen seas were slight, and so they were in the sense of ordinary botanising. But Hooker at twenty-two was already a man of wide views. He interested himself in all organic life, and found fascinating problems in the floating "plankton" of both warm and cold oceans, as well as in the depths down to four hundred fathoms. He collected, examined under the microscope, and drew all forms of life that came into his tow-nets and seines, or were brought up by dredges. He may be said to have originated a new line of study since largely pursued by geologists. For he examined samples of ooze from the ocean-floor of the Antarctic, and so founded the study of the organic deposits of the deep sea. Unfortunately, his collections were never fully worked up, so that many of the results remained unknown till re-discovered by later expeditions.

On the outward and return voyages, however, and in the intervals when the season was not favourable for entering the extreme southern seas, the expedition visited Ascension, St. Helena, the Cape, New Zealand, Tierra del Fuego, and the Falkland Islands. These visits were a secondary consequence of the voyage from the point of view of the Admiralty. But they gave Hooker the opportunity of collecting plants upon all the great circumpolar lands of the southern hemisphere. He made full use of his time, as his collections show. Already, in his letters home to his father, it was clear that great generalisations were forming in his mind on the distribution of the plants in these southern lands. The results he later welded together into his first great work, *The Antarctic Flora.* The collections were immense, and were forwarded regularly as opportunity allowed to his father, together with his scientific drawings.

The expedition finally returned to Woolwich in September, 1843. Since Hooker had sailed, his father had been appointed the first director of the Royal Gardens at Kew, and had left Glasgow. He was busily engaged in transmuting what had hitherto been a royal appanage into a Government establishment, which was to serve as a focus for all aspects of botanical science. Joseph at once became an enthusiastic coadjutor to his father, "working like a dragon," as his mother said. Later, however, it was arranged that he should be continued on half-pay as an assistant naval surgeon, so as to give him opportunity for working up his own collections, while Government undertook the cost of publication of the results. Incidentally he lectured in 1845 at Edinburgh University (for Graham, who was failing) and it was thought that he might succeed to the chair. But the success of J. Hutton Balfour in winning it when the vacancy actually arose decided the question of an academic career. He himself said, "I shall be quite content to go back without the professorship;" and he did. When, subsequently, he was offered the chair in Glasgow vacated by Balfour, he declined it, and the question of academic duty, which was never to his taste, did not arise again.

The years between the return from the Antarctic in 1843, and his departure for India in 1847, though filled with hard work upon the Antarctic results, were officially unsettled. The temporary duty in Edinburgh was succeeded by duty, also temporary, as official botanist to the Geological Survey of Great Britain. He was appointed in April 1846, but relinquished the post in November 1847 in order to start on his Himalayan journey. During that short period three memoirs were published by him on plants of the Coal Period. They embodied the results derived from the microscopic examination of plant tissues preserved in coal-balls, a study then newly introduced by Witham, and advanced by

Binney. It has since been greatly developed in Britain, but Hooker was among the first to engage in this branch of enquiry. Travelling was, however, in his blood, and the craving broke out afresh in him. He longed to see a tropical flora in a mountainous country, and to compare it at different levels with that of temperate and arctic zones. This is expressed in a letter of 1846 to Thomas Thomson, his old college friend, with whom he travelled in India. "I do long intensely," he says, "to go to the field with you, and especially to take the water". This aspiration was gratified later. There were at first several alternatives, but the call of the tropics was the most insistent. The Admiralty offered facilities for visiting the Malay Islands and Borneo. His own choice was between the Andes and the Himalaya, as providing special keys to the problems of geographical distribution, which now formed a background to all his work in the field. The final choice fell upon the Himalaya, in which he was influenced by promises of assistance from Dr. Falconer, the superintendent of the Calcutta garden. Before he left England his journey gained the recognition of Government. He not only received grants on the condition that the collections made should be located in the herbarium at Kew, but he was accredited by the Indian Government to the rulers and the British residents, in countries whose untrodden ways he was to explore. He sailed from England in November 1847 in the "Sidon," with Lord Dalhousie on board, who was on his way to take up the position of Governor-General of India. Later he was invited to join the Governor-General's suite, and so he entered India with all the assistance that official recognition could give. He remarks: "The Governor-General hints to me that he would like reports on the tea districts in India, . . . I need not say that I shall lay myself out to attend to his wishes in India. Assam, however, did not enter into my calculations."

Here, on the voyage out, was laid the germ from which sprang the tea industry of Darjeeling.

After passing the cold season of 1848 in making himself acquainted with the vegetation of the plains and hills of Western Bengal, he struck northward into the Sikkim Himalaya. At Darjeeling he became the welcome guest of Hodgson, resident at the Court of Nepal, and a great oriental scholar, who befriended him in many ways, and especially with his peculiar knowledge of the country into which Hooker was now to penetrate. He had been directed to Sikkim by Lord Auckland and Dr. Falconer, as to ground unbroken by traveller or naturalist. The story of this remarkable journey, its vicissitudes and results, including an account of the forcible detention of himself and his companion, Dr. Campbell, by a faction of the Court of Sikkim, is to be found in his *Himalayan Journal*. This most fascinating volume of travel was published in 1854. It tells how he spent two years in the botanical exploration and topographical survey of the State of Sikkim, and of a number of the passes leading into Thibet; and how, towards the close of 1848, he even crossed the western frontier of Sikkim, and explored a portion of Nepal that has never since been open to travellers. Hooker was not a mere specialist. His *Journal* is full of other observations than those on plants; they are ethnographical, ornithological, and entomological. His topographical results especially were of the highest importance. They formed the basis of a map published by the Indian Topographical Survey, and by its aid the operations of various campaigns and political missions have since been carried to a successful issue. Moreover, he made observations on the glaciers of the region; his notes supplying valuable material both to Lyell and to Darwin. He also accumulated data concerning the stupendous effect of sub-aerial denudation at great elevations. In 1849 he returned to Darjeeling, and busied himself with arranging his vast collections.

Here he was joined by his old fellow-student of Glasgow, Dr. Thomas Thomson, son of the professor of that name. The two friends spent the year 1850 in the botanical investigation of Eastern Bengal, Chittagong, Silhet, and the Khasia Hills. In 1851 they returned together to England.

The botanical object of these mountain expeditions in the tropics may not be clear to the lay public. It is easy to grasp the importance of the general flora of a vast area like India: the value of the timber, fibres, drugs, and other economic products would explain it. But why climb the inhospitable mountain sides, where vegetation is scanty, and that for the most part useless to man? The reply comes in Hooker's note on his collection on the flanks of Donkiah, where he climbed to a pass of 18,466 feet, and scrambled further upwards to 19,300 feet. "What keeps me here is the very curious flora." Between 17,000 and 19,000 feet were woolly Lactucas, Gentians, Senecios, and Saxifrages, all characteristic genera of temperate or even cold climates. In particular he was pleased with finding "my most Antarctic plant, *Lecanora miniata*," at the top of the pass, colouring stony hills wholly orange red, "exactly as the rocks of Cockburn Island were in 64° South". This extreme instance illustrates what he visited the Himalaya to find out. The plant-geographer, on testing the degree of correspondence of temperate, or even arctic floras with those of higher levels in the tropics, finds the identical species at the highest levels of the Himalaya, and at the extreme limit of vegetation on Antarctic Land.

On Hooker's return from India the question of his official position arose. For a time prospects were uncertain, but in 1855 he was appointed Assistant-Director of Kew, and was thus marked out as the probable successor of his father. The years from 1851 to 1860 were occupied with quiet work at home. But in 1860 he took part in a scientific visit to Syria and Palestine,

ascending Mount Lebanon to examine the decadent state of the famous cedars. This led to an enquiry into their relations to the deodar, and other cedars. One result of the journey was a sketch of the botany of Syria and Palestine, published in Smith's *Bible Dictionary.* The higher levels of Lebanon raised again the question of arctic plants about the summit, but he only succeeded in finding one, viz., *Oxyria reniformis.* The absence of others he attributes to the drought, and he assigns the failure of the cedars to the same cause.

Again a period of ten years intervened without any extensive travel. His next objective was Morocco. In 1871, with Mr. Ball and Mr. Maw, he penetrated the Atlas range, never before examined botanically. He had expected its flora to furnish a novel connecting link between the Atlantic and the African. But the results were negative, for there were no Alpines on the Atlas.

His last great journey was in 1877, when he was sixty years of age. With his old friend, Professor Asa Gray of Harvard, he visited the Western States of America, traversing Colorado, Wyoming, Utah, the Rocky Mountains, the Sierra Nevada, and California. The object of the journey was to collect evidence bearing upon the history of the remarkable relation of the plants of the Eastern States to those of Eastern Asia on the one hand, and on the other the sharp distinction between the arctic floras of America and Greenland. This was not a journey of adventure, but none the less it was one of hard work. Hooker returned with upwards of 1000 species of dried specimens, and the results were worked up into a joint report by Professor Asa Gray and himself.

This is an extraordinary record of travel, especially when it is remembered that all the journeys were fitted into the intervals of an otherwise busy life of scientific work and administration. At one time or another Hooker had touched upon every great continental area of the

earth's surface. Many isolated islands had also been examined by him, especially on the Antarctic voyage. Not only were fresh regions thus opened up for survey and collection, but each objective of the later journeys was definitely chosen for scientific reasons. Each expedition helped to suggest or to solve major problems. Such problems related not only to the distribution, but also to the very origin of species. Darwin saw this with unerring judgment as early as 1845. Hooker was then but twenty-eight years old, and the records of the Antarctic voyage were only in preparation. Nevertheless, Darwin wrote with assurance in a letter to Hooker himself, saying: "I know I shall live to see you the first authority in Europe on that grand subject, that almost keystone of the laws of creation, geographical distribution". Never was a forecast more fully justified. But that position which Hooker undoubtedly had later, could only have been attained through his personal experience as a traveller. Observation at first hand was the foundation on which he chiefly worked. Hooker the traveller prepared the way for Hooker the philosopher.

CHAPTER IV.

KEW.

THE noble establishment of the Royal Gardens at Kew is often spoken of as the Mecca of botanists. It is also a paradise for the populace of London. Few of the thousands who visit it on any summer's day, or of the tens of thousands who swarm there on Sundays and Bank holidays, have any idea of the position that Kew holds in the world of science, and in the Empire. They see horticulture at its best, and in the conservatories they sample the vegetation of the tropics. They see beautiful specimen trees, lining vistas of green sward, all spread out on a level area of river-bank, and they look upon it as a park specialised in the interest of botany and of the public, just as the Zoological Gardens are for Zoology. But few of them think of it in relation to the tea they drink at the restaurant in the gardens, or to the rubber tyres that carry them home in the evening. It is, however, the fact that the influences of Kew reach out so as to touch many such details of everyday life. Who shall say how far those influences may extend in the future, if only the policy of the past is continued and pressed forward by an intelligent Government? That policy was laid down and strenuously pursued by the Hookers, father and son. The two were so long associated together in the Directorship that it is difficult to disentangle the parts they severally played. Nor is there any need to attempt it, if while telling briefly the origin of Kew we recognise that it was they jointly who made it what it is.

The suburban village of Kew was for long a Royal residence; old-fashioned and often cramped houses of the Court still surround Kew Green; while Kew Palace with its grounds, now included in the Garden, was the social centre of the whole. In 1840 the Botanic Garden belonging to the Palace was transferred for the public benefit from the Crown to the Department of Woods and Forests. A scientific Director was required for the proposed public garden. Sir William Hooker had for some time been desirous of changing the scene of his activities from the relatively remote city of Glasgow to some more central point. The opening given by his appointment as the first Director not only satisfied this wish, but also put him in command of an establishment in which he saw, even in its undeveloped state, the possibility of expansion into a botanical centre worthy of the nation. He moved south in 1841, taking with him his private library, herbarium, and museum, which finally formed the foundation of the great scientific collections of Kew.

At the time of Sir William's appointment the garden was in a very unsatisfactory state. The acreage was small: the plant-houses were old, and of obsolete pattern. There was no library, nor any herbarium. In fact the Kew Garden was in 1841 a mere appanage to a palace, where a more than usually extensive collection of plants was grown. It was the arrival of Sir William Hooker, with his collections and his library, and above all with his zeal, knowledge, and judgment, that stamped a scientific ideal upon Kew. His collections were at first his own private property. He had not even an official house. Like so many of the best things of this country, Kew was largely founded on private enterprise. During the first years Sir William worked alone. Joseph was still in the Antarctic: and even when he returned in 1843 it was only for the short interval before his Himalayan journey. It was not till his return from India in 1851

that he took up residence at Kew. In 1855 he became Assistant Director till his father's death in 1865. From that time onwards till his retirement in 1885 Sir Joseph Hooker was Director.

The ideal of a National Botanic Garden had already been sketched in the report of a Royal Commission a few years before, upon the question of retaining the Botanic Gardens at Kew. It was pointed out that "A National Botanic Garden would be the centre around which all lesser establishments should be arranged: they should all be placed under the control of the chief of that garden, acting with him, and through him with each other, recording constantly their proceedings, explaining their wants, receiving supplies, and aiding the mother-country in everything useful in the vegetable kingdom: medicine, commerce, agriculture, horticulture, and many branches of manufacture would derive considerable advantage from the establishment of such a system. From a garden of this kind Government could always obtain authentic and official information upon points connected with the establishment of new colonies: it would afford the plants required on these occasions, without its being necessary, as now, to apply to the officers of private establishments for advice and help."

On entering office Sir William Hooker determined to follow the suggestions of the report. The original area of the Garden was only about 18 acres, and the Chief Commissioner was strongly opposed to its enlargement. But in 1842 additional ground was taken in, so as to afford an entrance from Kew Green, now the principal gate of the Garden. In 1843 there were added 48 acres of arboretum, including the site of the Palm House, which was commenced in 1844. Other houses followed, together with a Museum of Economic Botany, the first of its kind to be established. In 1853 an official house was found for the Director, while another Crown house adjoining Kew Green was handed over for the

growing herbarium and library. Later the area was still further extended, and new houses and museums built, till at the present day some 650 acres are under the Director's control, while the staff is considerably above 100 men.

The public sees only the outside aspect of the real Kew. It is impossible that it should be otherwise, though in the long run they are the gainers by its existence. It is upon the parts of the garden that the public never sees that the real value of Kew chiefly rests. The Director's office is naturally the official centre. There the Hookers attended to the day-by-day administration of the garden itself. But in addition there was a growing bulk of correspondence, on the one hand with botanists all over the world, on the other with the Government Departments, and especially with the Indian and Colonial Offices. As the activity of the garden extended there grew up a large staff of scientific experts and artists, whose duties centred round the herbarium and library. These all looked to the Director for their guidance and control. The descriptive work prepared by them for publication began to take formidable dimensions. The production of the *Flora of British India*, and Floras of the several Colonies, the publication of which was conducted under Government subvention, had to be organised and carried through. These matters are mentioned here so as to give some idea of the extent and complexity of the work which was carried through in the time of the Hookers, and it has since been continued and ever extended. For ten years as Assistant Director, and for twenty years as Director, Sir Joseph Hooker guided this complex machine. The efficiency of his rule was shown by the increasing estimation in which the garden was held by all who were able to judge.

It was the founding of the herbarium and library at Kew which, more than anything else, strengthened the scientific establishment. As taken over from the

Crown the garden possessed neither. But Sir William had brought with him from Glasgow his own collections, already the most extensive in private hands. For long years after coming to Kew he maintained and added to his store at his own expense. But finally his collections were acquired after his death by Government. His herbarium was merged with the fine herbarium of Bentham already presented to the nation in 1857. Thus the opening years of Sir Joseph's directorate saw the organisation on a public basis of the magnificent herbarium and library, which now contains not only his father's collections, but also his own. Among the enormous additions since made to the herbarium of Kew, its greatest interest will always be centred in the Hookerian collections which it contains.

The herbarium building thus holds in its most condensed form the scientific essence of Kew. Originally a dwelling-house belonging to the Crown, it has been extended by two large wings, in which the herbarium-cases are arranged on successive galleries. The older part of the building is shelved and contains the library, the bound volumes of correspondence, and the collections of drawings, copies of published plates, and maps. Here the great series of Indian and Colonial floras has been worked out, while the documentary evidence upon which they were based is to be found in the actual specimens stored in the adjoining wings. Kew, and especially the herbarium-building, may be regarded as a co-ordinating centre of botanical knowledge, primarily for the Empire, but also for the world at large. Its effect is far more extended than that of mere holiday amusement for the crowd—far more even than that intelligent interest which a certain proportion of the crowd takes in the collections of living plants, or in the contents of the museums. It is a structure built upon the solid work of the Hookers, father and son. Their dynasty was even extended by marriage to the third

generation in the person of Sir Joseph's son-in-law, Sir William Thiselton-Dyer, who succeeded him in the Directorate.

There is only one other family record in European botany which can be compared with this of the Hookers at Kew. It is that of the de Candolles of Geneva. For three generations they also were in the forefront of Systematic Botany. The greatest of them was A. P. de Candolle. He was a most versatile writer on physiology and on geographical distribution. But his greatest work was the *Prodromus Systematis Naturalis*, in which all known plants were to be arranged according to his natural system, and described at length. He initiated this stupendous work, but did not live to complete it. It was based chiefly upon his own collections, still preserved in the family house in the Place St. Pierre, at Geneva. We visit it with interest, and pious respect. But it is evident that the active Science of the present day has drifted elsewhere. The dynasty of de Candolle, brilliant and effective as it was, has left behind it no co-ordinating machine like that of the establishment at Kew.

It might be thought that such drafts upon the time and energy of a scientific man as were involved in the directorship of Kew would leave no opportunity for other duties. But it was while thus burdened that Sir Joseph was called to the highest administrative office in Science in Great Britain. He served as President of the Royal Society from 1873 to 1878. The obligations of that position are far from being limited to the requirements of the Society itself. The Government of the day has always been in the habit of taking its President and officials into consultation in scientific matters of public importance. In these years the administrative demands upon Sir Joseph were the greatest in his life. They are marked by a temporary pause in the stream of his publications. None of his own larger works date from

this period. It happens only too often in this country that our ablest men are thus paralysed in their scientific careers by the potent vortex of administration. Not a few succumb, and cease altogether to produce. They are caught as in the eddy of the Lorelei, and are so hopelessly entangled that they never emerge again. They fail to realise, or realise too late, that the administration of matters relating to Science is not an end in itself, but only a means to an end. Some, the steadfast and invincible seekers after truth, though held by the eddy for a time, pass again into the main stream. Hooker was one of these. His Presidency of the Royal Society ended after five years. Seven years later he demitted office as Director of Kew, under the Civil Service rule. He was thus free in 1885, still a young man in vigour though not in years. For over a quarter of a century after retirement he devoted the energy of his old age to peculiarly fruitful scientific work. Thus the administrative tie upon him was only temporary. So long as it lasted he faithfully obeyed the call of duty, notwithstanding the restrictions it imposed.

CHAPTER V.

AUTHORSHIP.

THE great bulk of Sir Joseph Hooker's published works were written frankly as by a botanist for botanists. He rarely wrote for the general public; but he did so in his *Himalayan Journal*, and its popularity showed that he possessed the power of fascinating his readers. The volume ranks with Darwin's *Voyage of the "Beagle"*, and Wallace's *Malay Archipelago;* books which form a veritable trilogy of the golden age of travel in pursuit of Science. Another of his works of quite a different class has secured a wide circulation. In 1870 he produced his *Student's Flora of the British Islands*, of which later editions appeared in 1878 and 1884. The book was published to "supply students and field botanists with a fuller account of the plants of the British Isles than the manuals hitherto in use aim at giving". It still holds the field, though it requires to be brought up to date in point of classification and nomenclature. Thus the greatest systematist of his time was yet willing to help those of less ambitious flights. It will not be necessary to give an exhaustive list of the works upon which Hooker's reputation as a scientific systematist was founded. They are too numerous for that. It must suffice to indicate the nature and scope of four of the greatest of them, viz., the *Antarctic Flora;* the *Flora of British India;* the *Genera Plantarum;* and the *Kew Index.*

We have seen how on the Antarctic voyage Hooker

had the opportunity of collecting on all the great circumpolar areas of the southern hemisphere. His *Antarctic Flora* was based on the collections and observations then made. It was published in six large quarto volumes. The first related to the Lord Auckland and Campbell Islands (1843-1845); the second to Fuegia and the Falkland Islands (1845-1847); the third and fourth to New Zealand (1851-1853); and the fifth and sixth to Tasmania (1853-1860). They describe about 3000 species, while on the 530 plates 1095 species are depicted, usually with detailed analytical drawings. But these volumes did not merely contain reports of explorations, and descriptions of the many new species collected. There is much more than this in them. All the known facts that could be gathered were incorporated, so that they became systematically elaborated and complete floras of the several countries. Moreover, in the last of them, the *Flora Tasmaniae*, there is an Introductory Essay, which in itself would have made Hooker famous. We shall return to this later. Meanwhile we recognise that the publication of the *Botanical Results of Ross's Voyage* established Hooker's reputation as a traveller and botanist of the first rank.

What he thus did for the Antarctic in his youth he continued in mature life for British India. While the publication of the *Antarctic Flora* was still in progress, he made his Indian journeys. The vast collections amassed by himself and Dr. Thomson were consigned by agreement with Government to Kew. Thither had also been brought in 1858 "seven waggon-loads of collections from the cellars of the India House in Leadenhall Street, where they had been accumulating for many years". They included the herbaria of Falconer and Griffith. Such materials, with other large additions made from time to time, flowed into the already rich herbarium at Kew. This was the material upon which Sir Joseph Hooker was to base his *Flora of British India*.

Already in 1855 Sir Joseph, with his Glasgow college friend, Thomas Thomson, had essayed to prepare a "Flora Indica". It never advanced beyond its first volume. But if it had been completed on the scale set by that volume, it would have reached nearly 12,000 pages! After a pause of over fifteen years Hooker made a fresh start, aided now by a staff of collaborators, and the *Flora of British India* was the result. It was conceived, he says with regret, upon a restricted plan. Nevertheless it ran to seven volumes, published between the years 1872 and 1897. There are nearly 6000 pages of letterpress, relating to 16,000 species. It is, he says in the Preface, a pioneer work, and necessarily incomplete. But he hopes it may "help the phytographer to discuss problems of distribution of plants from the point of view of what is perhaps the richest, and is certainly the most varied botanical area on the surface of the globe".

Scarcely was this great work ended when Dr. Trimen died. He left the *Ceylon Flora*, on which he had been engaged, incomplete. Three volumes were already published, but the fourth was far from finished, and the fifth hardly touched. The Ceylon Government applied to Hooker, and though he was now eighty years of age, he responded to the call. The completing volumes were issued in 1898 and 1900. This was no mere raking over afresh the materials worked already into the *Indian Flora*. For Ceylon includes a strong Malayan element in its vegetation. It has, moreover, a very large number of endemic species, and even genera. This last floristic work of Sir Joseph may be held fitly to round off his treatment of the Indian Peninsula. His last contribution to its botany was in the form of a "Sketch of the Vegetation of the Indian Empire," including Ceylon, Burma, and the Malay Peninsula. It was written for the *Imperial Gazetteer*, at the request of the Government of India. No one could have been so well qualified for

this as the veteran who had spent more than half a century in preparation for it. It was published in 1904, and forms the natural close to the most remarkable study of a vast and varied flora that has ever been carried through by one ruling mind.

The third of Hooker's great systematic works is the *Genera Plantarum* produced in collaboration with Mr. Bentham. Its three massive volumes contain a codification of the Latin diagnoses of all the genera of flowering plants known at the date of publication. It is essentially a work for the technical botanist, but for him it is indispensable. The only real predecessors of this monumental work were the *Genera Plantarum* of Linnæus (1737-1764), and that of de Jussieu (1789), to which may be added that of Endlicher (1836-1840). Both Bentham and Hooker had felt the inconvenience of the want of a *Genera Plantarum* founded on actual observation, to replace the antiquated ones of Endlicher and Meissner, both of which, especially the latter, had been in great measure mere compilations. In view of the gigantic nature of the task they joined forces. But the authors specially wished that the whole should be considered as the joint production of them both. The characters embodied in the diagnoses were drawn from the actual examination of specimens. These could only be derived from a reliable and rich herbarium, such as that of Kew had now become. Thus the book is not in any sense a compilation from the work of earlier writers, but it contains a redrafting of the diagnoses on the basis of personal observation. Probably into no work on Botany is there condensed so wide a field of personally recorded fact, expressed in such concise terms. The authors were both mature observers. But while Hooker was at home in the forest and the jungle, Bentham was rather a denizen of the herbarium. His education as a conveyancing barrister gave point to his naturally acute mind in the exact wording of diagnoses. The difficulty

of the task of Bentham and Hooker was greater than that of their predecessors by reason of their wider knowledge, and the increase in the number of recognised genera consequent on the activity of collectors the world over. But their *Genera Plantarum* was on that account a nearer approach to finality. Hitherto its supremacy has not been challenged. On the other hand it has formed the source from which diagnoses have been liberally borrowed. It will probably long remain the ultimate court of appeal on the exact definition of genera.

The fourth of the great systematic works of Hooker mentioned above was the *Index Kewensis*. It was produced upon the plan and under the supervision of Sir Joseph by Mr. Daydon Jackson and a staff of clerks. The publication began in 1893, and successive supplements to its four quarto volumes are still appearing at intervals. The expense was borne by Charles Darwin. The scheme originated in the difficulty he had found in the accurate naming of plants. For "synonyms" have frequently been given by different writers to the same species, and this had led to endless confusion. The object of the Index was to provide an authoritative list of all the names that have been used, with reference to the author of each and to its place of publication. The habitat of the plant was also to be given. The correct name in use according to certain well-recognised rules of nomenclature was to be indicated by type different from that of the synonyms superseded by it. The only predecessors of such an Index was Steudel's *Nomenclator Botanicus*, a book greatly prized by Darwin, though long out of date. He wished at first to produce a modern edition of Steudel's *Nomenclator*. This idea was, however, amended, and it was resolved to construct a new list of genera and species, founded upon Bentham and Hooker's *Genera Plantarum*. Sir Joseph Hooker was asked by Mr. Darwin to take into consideration the

extent and scope of the proposed work, and to suggest the best means of having it executed. He undertook the task, and it was he who laid out the lines to be followed. After years of labour by Mr. Daydon Jackson and his staff, the work was produced. But Sir Joseph read and narrowly criticised all the proofs. Imagine four large quarto volumes, containing in the aggregate 2500 pages, each page bearing three columns of close print, and each column about fifty names. The total figures out to about 375,000 specific names, all of which were critically considered by the octogenarian editor! Surely no greater technical benefit was ever conferred upon a future generation by the veterans of science than this Index. It smooths the way for every systematist who comes after. It stands as a monument to an intimate friendship. It bears witness to the munificence of Darwin, and the ungrudging personal care of Hooker.

This brief analysis of the four greatest systematic works of Hooker will have sufficed to show how fully he was imbued with the old systematic methods: how he advanced, improved and extended them, and was in his time their chief exponent. His father had held a similar position in the generation before him. But the elder Hooker, true to his generation, treated his species as fixed and immutable. He did not generalise from them. His end was attained by their accurate recognition, delineation, description, and classification. The younger Hooker, while in this work he was not a whit behind the best of his predecessors, saw further than they. He was not satisfied with the mere record of species as they are. He sought to penetrate the mystery of the origin of species. In fact he was not merely a Scientific Systematist in the older sense. He was a *Philosophical Biologist* in the new and nascent sense of the middle period of the nineteenth century. He was an almost life-long friend of Charles Darwin. He was the first confidant of his species-theory, and, excepting Wallace,

its first whole-hearted adherent. But he was also Darwin's constant and welcome adviser and critic. Well indeed was it for the successful launch of evolutionary theory that old-fashioned systematists took it in hand. Both Darwin and Hooker had wide and detailed knowledge of species as the starting-point of their induction.

The fame of Sir Joseph Hooker as a Philosophical Biologist rests upon a masterly series of Essays and Addresses. The chief of these were the "Introductory Essay to the *Flora Tasmaniae*," dealing with the Antarctic flora as a whole; the "Essay on the Distribution of Arctic Plants," published in 1862; the "Discourse on Insular Floras in 1866"; the Presidential Address to the British Association at Norwich in 1868; his Address at York, in 1881, on Geographical Distribution; and finally, the "Essay on the Vegetation of India," published in 1904. In no case were these mere inspirations of the moment. They were the outcome of arduous journeys to observe and to collect, and subsequently of careful analysis of the specimens and of the facts. The dates of publication bear this out. The essay on the Antarctic flora appeared about twenty years after the completion of the voyage. The essay on the Vegetation of India was not published till more than half a century after Hooker first set foot in India. It is upon such foundations that Hooker's reputation as a great constructive thinker is securely based.

The first-named of these essays will probably be estimated as the most notable of them all in the History of Science. It was completed in November, 1859, barely a year after the joint communications of Darwin and Wallace to the Linnæan Society, and before the *Origin of Species* had appeared. It was to this essay that Darwin referred when he wrote that "Hooker has come round, and will publish his belief soon". But this publication of his belief was not merely an echo of assent to Darwin's own opinions. It was a reasoned

statement, advanced upon the basis of his "own self-thought," and his own wide systematic and geographical experience. From these sources he drew for himself support for the "hypothesis that species are derivative, and mutable". He points out how the natural history of Australia seemed specially suited to test such a theory, on account of the comparative uniformity of the physical features being accompanied by a great variety in its flora, and the peculiarity of both its fauna and flora, as compared with other countries. After the test had been made, on the basis of study of some 8000 species, their characters, their spread, and their relations to those of other lands, he concludes decisively in favour of mutability and a doctrine of progression.

How highly this essay was esteemed by his contemporaries is shown by the expressions of Lyell and of Darwin. The former writes: "I have just finished the reading of your splendid essay on the Origin of Species, as illustrated by your wide botanical experience, and think it goes far to raise the variety-making hypothesis to the rank of a theory, as accounting for the manner in which new species enter the world". Darwin wrote: "I have finished your essay. To my judgment it is by far the grandest and most interesting essay on subjects of the nature discussed I have ever read."

But, besides its historical interest in relation to the Species-Question, the essay contained what was up to its time the most scientific treatment of a large area from the point of view of the Plant-Geographer. He found that the Antarctic, like the Arctic flora, is very uniform round the globe. The same species in many cases occur on every island, though thousands of miles of ocean may intervene. Many of these species reappear on the mountains of Southern Chili, Australia, Tasmania, and New Zealand. The southern temperate floras, on the other hand, of South America, South Africa, Australia, and New Zealand differ more among themselves than do

the floras of Europe, Northern Asia, and North America. To explain these facts he suggested the probable former existence, during a warmer period than the present, of a centre of creation of new species in the Southern Ocean, in the form of either a continent or an archipelago, from which the Antarctic flora radiated. This hypothesis has since been held open to doubt. But the fact that it was suggested shows the broad view which he was prepared to take of the problem before him. His method was essentially that which is now styled "Ecological". Many hold this to be a new phase of botanical enquiry, introduced by Professor Warming in 1895. No one will deny the value of the increased precision which he then brought into such studies. But in point of fact it was Ecology on the grand scale that Sir Joseph Hooker practised in the Antarctic in 1840. Moreover it was pursued, not in regions of old civilisation, but in lands where nature held her sway untouched by the hand of man.

This essay on the flora of the Antarctic was the prototype of the great series. Sir Joseph examined the Arctic flora from similar points of view. He explained the circumpolar uniformity which it shows, and the prevalence of Scandinavian types, together with the peculiarly limited nature of the flora of the southward peninsula of Greenland. He extended his enquiries to oceanic islands. He pointed out that the conditions which dictated circumpolar distribution are absent from them; but that other conditions exist in them which account for the strange features which their vegetation shows. He extended the application of such methods to the Himalaya and to Central Asia. He joined with Asa Gray in like enquiries in North America. The latter had already given a scientific explanation of the surprising fact that the plants of the Eastern States resemble more nearly those of China than do those of the Pacific slope. In resolving these and other problems

it was not only the vegetation itself that was studied. The changes of climate in geological time, and of the earth's crust as demonstrated by geologists, formed part of the basis on which he worked. For it is facts such as these which have determined the migration of floras. And migration, as well as mutability of species, entered into most of his speculations. The essays of this magnificent series are like pictures painted with a full brush. The boldness and mastery which they show sprang from long discipline and wide experience.

Finally, the chief results of the Phyto-Geographical work of himself and of others were summed up in the great address on "Geographical Distribution" at York. The Jubilee of the British Association was held there in 1881. It had been decided that each section should be presided over by a past President of the Association, and he had occupied that position at Norwich in 1868. Accordingly at York, Hooker was appointed President of the Geographical Section, and he chose as the subject of his address "The Geographical Distribution of Organic Beings". To him it illustrated "the inter-dependence of those sciences which the geographer should study". It is not enough merely to observe the topography of organisms, but their hypsometrical distribution as regards height above the sea-level must also be noted. Further, the changes of area and of altitude in exposed land-surfaces of which geology gives evidence, are essential features in the problem, together with the changes of climate, such as have determined the advance and retrocession of glacial conditions. Having noted these factors, he continued thus: "With the establishment of the doctrine of orderly evolution of species under known laws I close this list of those recognised principles of the science of geographical distribution, which must guide all who enter upon its pursuit. As Humboldt was its founder, and Forbes its reformer, so we must regard Darwin as its latest and greatest law-giver."

May we not now add to these words of his, that Hooker was himself its greatest exponent?

Certain other memoirs fall into a distinct class, which may be styled *Morphological* in a sense established early in the last century. The exact microscopic analysis of the structure and development of plants had been greatly advanced on the continent about the close of the eighteenth century, and early in the nineteenth they were specially pursued by Schleiden and Hofmeister. In Britain the great outburst of systematic work in the first half of the nineteenth century had had a deleterious effect. By its success work in the laboratory seemed to be in danger of being strangled in the land of its birth. But Sir Joseph Hooker formed a link between the herbarium and the laboratory. He held a balance between them by a series of memoirs which were "Morphological" in the more modern sense. He studied the curious parasitic Balanophoraceae in this way; also the Pitcher Plant, *Nepenthes*. The physiological significance of its urns, and of the organs of other carnivorous plants, formed the subject of his address before the British Association at Belfast in 1874. But previous to this, in 1863 he had produced his great monograph on *Welwitschia*, that most remarkable of all the Gymnosperms, which grows in a limited area of South-West Africa, recently German. The plant is of so unusual a character that it was a real triumph to trace the comparisons leading to the systematic position which he assigned to it. Much modern work with more refined methods than his has only served to confirm his classification of one of the most bizarre plants in the vegetable kingdom. Such work bore the mark of a time later than that in which it was produced. These memoirs serve as another indication of the breadth of Hooker's scientific outlook. When we take into consideration his various published works, of which those here quoted are merely the most notable examples, the impression is left

of high versatility, combined with keen insight and persistence in the acquisition of detail, and great power of using facts constructively. Hooker's work throughout was constructive, and it led to positive advances in science which form a lasting monument to his long life.

CHAPTER VI.

THE SPECIES-QUESTION.

THE middle of the nineteenth century was a critical period in the history of Biological Science, and especially of Botany. The glamour of the Linnæan period had faded, and the natural system of classification of plants initiated by de Jussieu had fully established its position, and had been worked out into detail, taking its most elaborate form in the *Prodromus* of de Candolle. That great luminary of Geneva died in 1841, leaving his uncompleted work in the hands of his son, Alphonse. In England, Robert Brown was in the full plenitude of his powers, and in possession of the Banksian herbarium was evolving out of its rich treasures new principles of classification, and new morphological comparisons. Morphology was being gradually differentiated from mere systematic botany as a separate discipline. Nothing contributed more effectively to this than the publication of *Die Botanik als inductive Wissenschaft*, by Schleiden in 1842: for in it development and embryology were for the first time indicated as the foundation of all insight into morphology. Thus a new and more profound basis for classification was gradually being evolved. But the dogma of constancy of species still reigned. It was to continue for some years after the middle of the century to hold the ground, notwithstanding its growing inconsistency with ascertained facts and well-grounded comparisons.

The period immediately before the middle of the

century was pregnant with other new developments. The study of protoplasm engaged the attention of Von Mohl. The nucleus was recognised by Brown as a constant feature of the cell. Apical growth was investigated by Naegeli and Leitgeb. The discovery of the sexuality of ferns, and the completion of their life-story by Bischoff, Naegeli, and Suminski led up to the great generalisation of Hofmeister. These years thus witnessed the initiation of morphology in its modern development, as based upon the whole cycle of life of the organisms compared. On the other hand, Lyell's *Principles of Geology* had appeared and obtained wide acceptance. Darwin back from the "Beagle" was working at his barnacles: Joseph Hooker was occupied first with his Antarctic voyage, and up till 1851 with the Himalayan journey. These three great figures, the forerunner of Evolution, the author of the *Origin of Species*, and Darwin's first adherent among biologists, were thus in their various ways working towards that great generalisation which was so soon to revolutionise biological thought.

Before we trace the part which Hooker himself played in the drama of evolutionary theory, it will be well to glance at his personal relations with Darwin himself. It has been seen how he read the proof-sheets of the *Voyage of the "Beagle"* while still in his last year of medical study. But before he started for the Antarctic he was introduced to its author. It was in Trafalgar Square, and the interview was brief but cordial. On returning from the Antarctic, correspondence was opened in 1843. In January 1844 Hooker received the memorable letter confiding to him the germ of the Theory of Descent. Darwin wrote thus: "At last gleams of light have come, and I am almost convinced that species are not (it is like confessing murder) immutable: I think I have found (here's presumption!) the simple way by which species become exquisitely adapted to various ends". This was probably the first communica-

tion by Darwin of his species-theory to any scientific colleague.

The correspondence thus happily initiated between Darwin and Hooker is preserved in the *Life and Letters of Charles Darwin*, and in the two volumes of *Letters* subsequently published. Recent welcome additions to the correspondence are also included in the *Life and Letters of Sir J. D. Hooker*, by L. Huxley, 1918. The letters show on the one hand the rapid growth of a deep friendship between these two potent minds, which ended only beside the grave of Darwin in Westminister Abbey. But what is more important is that these letters reveal, in a way that none of the published work of either could have done, the steps in the growth of the great generalisation. We read of the doubts of one or the other; the gradual accumulation of material facts; the criticisms and amendments in face of new evidence; and the slow progress from tentative hypothesis to assured belief. We ourselves have grown up since the clash of opinion for and against the mutability of species died down. It is hard for us to understand the strength of the feelings aroused: the bitterness of the attack by the opponents of the theory, and the fortitude demanded from its adherents. It is best to obtain evidence of such matters at first hand; and this is what is supplied by the correspondence between Darwin and Hooker.

How complete the understanding between the friends soon became is shown by the provisions made by Darwin for the publication of his manuscripts in case of sudden death. He wrote in August 1854 the definite direction "Hooker by far the best man to edit my species volume": and this notwithstanding that he writes to him as a "stern and awful judge and sceptic". But again, in a letter a few months later, he says to him: "I forgot at the moment that you are the one living soul from whom I have constantly received sympathy". Hooker was in fact not only Darwin's first confidant, but also the first to

accept his theory of the mutability of species. But even he did not fully assent to it till after its first publication. The latter point comes out clearly from the letters. In January 1859, six months after the reading of their joint communications to the Linnæan Society, Darwin writes to Wallace: "You ask about Lyell's frame of mind. I think he is somewhat staggered, but does not give in. . . . I think he will end by being perverted. Dr. Hooker has become almost as heterodox as you or I, and I look at Hooker as by far the most capable judge in Europe." In September 1859 Darwin writes to W. D. Fox: "Lyell has read about half of the volume in clean sheets. . . . He is wavering so much about the immutability of species that I expect he will come round. Hooker has come round, and will publish his belief soon." In the following month, writing to Hooker, Darwin says: "I have spoken of you here as a convert made by me: but I know well how much larger the share has been of your own self-thought". A letter to Wallace of November 1859 bears this postscript: "I think that I told you before that Hooker is a complete convert. If I can convert Huxley I shall be content". And lastly, in a letter to W. B. Carpenter, of the same month, Darwin says: "As yet I know only one believer, but I look at him as of the greatest authority, viz., Hooker". These quotations clearly show that, while Lyell wavered, and Huxley had not yet come in, Hooker was a complete adherent in 1859 to the doctrine of the mutability of species. Excepting Wallace, he was the first, in fact, of the great group that stood round Darwin, as he was the last of them to survive.

The story of the joint communication of Darwin and of Wallace to the Linnæan Society "On the Tendency of Species to form Varieties, and on the Perpetuation of Varieties and Species by Natural Means of Selection" has been frequently told. It was Sir Charles Lyell and Sir Joseph Hooker who jointly, and with the authors'

permission, communicated the two papers to the society, together with the evidence of the priority of Darwin in the enquiry. Nothing, therefore, could have been more apposite than the personal history which Sir Joseph gave at the Darwin-Wallace celebration, held by the Linnæan Society in 1908. He then told, at first hand, the exact circumstances under which the joint papers were produced. Nor could the expressions used by the President when thanking Sir Joseph, and presenting to him the Darwin-Wallace Medal, have been improved. He said: "The incalculable benefit that your constant friendship, advice, and alliance were to Mr. Darwin himself, is summed up in his own words, used in 1864: 'You have represented for many years the whole great public to me'." The President then added: "Of all men living it is to you more than to any other that the great generalisation of Darwin and Wallace owes its triumph". These words were uttered many years after Huxley's death. The names of Huxley and of Hooker will always be associated as the public defenders of evolution against attacks stimulated by preconception, one might even say by bigotry. These came to a head at the Oxford meeting of the British Association in 1860. Darwin himself was not present. The chief onslaught came from the Bishop of Oxford, and the full brunt of it was taken by Huxley who replied with his celebrated fighting speech. Huxley was followed by Hooker. He demonstrated that the Bishop could never have read the *Origin*, and that he was ignorant of the rudiments of Botanical Science. The meeting then collapsed, and in Hooker's own words, he was "congratulated and thanked by the blackest coats and the whitest stocks in Oxford".

The very last appearance of Hooker at any large public gathering of biologists was at the centenary celebration of Darwin's birth at Cambridge in 1909. No one there present will forget the tall figure of the veteran, aged, but still vigorous, with vivacity in every feature.

How gladly he accepted the congratulations of his many friends, and how heartily he rejoiced over the full acceptance of the theory he had himself done so much to promote! The end came only two years later, in December, 1911. Many will have wished that the great group of the protagonists of evolution, Darwin, Lyell, and Hooker, should have found their final resting-place together in Westminster Abbey. But this was not to be. Personal and family ties held him closer to Kew, and he lies there in classic ground beside his father.

CHAPTER VII.

PERSONAL CHARACTERISTICS.

IN the preceding chapters the attempt has been made to present Sir Joseph Hooker in his public capacity, as a "Pioneer of Science". It remains very briefly to sketch his personal characteristics. Though Darwin might half-humorously call him a "stern and awful judge," he was in reality a very human and kindly man. He played with children, not only his own. His visits to Down were popular with the young Darwins. He took a peculiarly sympathetic interest in the work and in the careers of the younger botanists: and even after his retirement that interest still remained. He sprang from a family of serious thought. The "Judicious Hooker" was one of his predecessors. His own branch of the family became related by marriage and by friendship with members of the Norwich School of Painters, and with the Quaker families of East Anglia. Such alliances and friendships had their effect upon the home life of Sir William Hooker, giving it a tinge of austerity combined with high culture, and they undoubtedly had their effect in moulding the mentality of his son. A serious sense of duty was a leading characteristic. This combined with strong enthusiasm for science was the key to his prolific life. His temper was equable, and well under command. But there was one public occasion when his wrath was justly roused, and expressed in strong terms. It was when maladministration by his official chief, the

First Commissioner of Works, bid fair to ruin the prospects of the scientific establishment at Kew. He won in the encounter, and the incident though sufficiently acute at the time, now serves to show that Hooker possessed an official will not easily bent, and that latent fires were in reserve in his apparently quiet nature.

A very marked feature was his strong family affection and love of home. It is shown by warm passages in his letters from the Antarctic, which often contained pointed comparison of striking views with scenery known to the family, and the expressed wish that they could share his pleasures. His affection for his elder brother comes out particularly in the expressions evoked by his early death. His regard for his father, so often shown in life, stimulated the elaborate record of his works published long after his death in the *Annals of Botany*, 1902.

Personally, Sir Joseph Hooker was of tall and rather spare build, with features striking and forcible rather than handsome, and he was somewhat unconventional in dress. As a young man he was very active. At the age of 19 his mother tells how he returned on foot 24 miles from Helensburgh to Glasgow on a Sunday afternoon, so as not to miss a Monday morning lecture. His activity stood him in good stead in the Antarctic, and the Himalaya. His endurance at high levels was remarkable. Without the elaborate preparation and equipment which has enabled other mountaineers to reach greater heights, he climbed well over 19,000 feet on the slopes of Donkiah. Later in life the exacting weeks of collecting in the Rocky Mountains and California showed that at the age of 60 he was still able to combine continuous exertion with intense scientific activity. He was twice married. First in 1851, to Frances, daughter of Professor Henslow of Cambridge, who recommended Darwin as naturalist for the "Beagle". She, as the daughter of one botanist and wife of another, shared in his pursuits. She even played her own part in

translating the *Traité* of Le Maout and Decaisne, a volume to which Sir Joseph added many valuable notes. She died in 1874, leaving him with a young family of four sons and two daughters. He married again in 1876, Hyacinth, Lady Jardine, by whom he had two sons. None of his family continued directly the botanical succession. But his elder daughter married Sir William Thiselton-Dyer, who succeeded her father as Director of Kew.

Sir Joseph appears never to have been addicted to games or sport. When his elder brother would be fishing, he as a boy would be collecting plants or insects. His zeal for science left him little time for mere amusement. In later life he gave as his recreations in *Who's Who*, Natural Science, and the collection of Wedgwood ware, chiefly the portraits of eminent men. As a collector he was a real enthusiast. "I look them over every Sunday morning," he says of his Wedgwood. He gave specimens of the ware as wedding presents, and often as presents without any wedding. It was then fitting that a successful medallion of himself should have been executed by the firm.

Naturally from his official position Hooker knew all the leading scientific men of the day. His garden parties at Kew were well-known reunions of them. His most enduring and intimate friendship was with Darwin. His long alliance with Bentham ended only with Bentham's death. Huxley was a constant ally. Tyndall, Busk, Spencer, Lubbock, and Frankland were also close friends. What then more natural than that they, with some others, should constitute a social body, the X-Club, to meet at intervals for dinner and discussion? Founded in 1864, its meetings continued till 1892. For a generation it held together, in the interest of science and sociability, a group of the most distinguished men of the time—all intimate friends. As they died or grew old the meetings thinned. New blood was not admitted,

and the X-Club finally collapsed, without any formal dissolution. That Sir Joseph himself outlived all the other members was the natural consequence of survival to extreme age. Combining as he did a burning enthusiasm for science and a kindly sympathy with those who joined with him in its pursuit, he lived his long life in happy relations with his fellows, and left not a tinge of bitter feeling behind him at his death.

CHAPTER VIII.

HOOKER'S POSITION AS A MAN OF SCIENCE.

SIR JOSEPH HOOKER died on 10th December 1911, at the age of 94, full of years and of honours. The list of the distinctions heaped upon him fills ten pages at the end of the *Life*. Thus contemporary Science gave its verdict in no uncertain way. The opinion of a period is not necessarily the opinion of posterity. Yet there are solid reasons in the present case for believing that the two will not diverge. In attempting to analyse and appreciate those qualities which gave Sir Joseph Hooker his assured position among his contemporaries, it may be possible at the same time to recognise the permanent features of his work. For it is these which will secure for him a prominent place in the History of Science, as it may be reviewed from some vantage point in the remote future.

What first strikes the observer is the mere superficial fact of an unusually long life, zealously used. In the year 1837, while still a student, he described three new species of Mosses. In 1911 he established several new species of *Impatiens*. Thus his published record covers a period of three-quarters of a century. Doubtless this was a factor, but it was only a minor one. What is more important is that to the very end he never grew really old. He never outlived his freshness of interest in a new discovery, whether his own or that of his younger contemporaries. The extraordinary length of his productive period undoubtedly made the great

volume of his work possible. But it is not upon the mere quantity of the output, vast though it is, that his title to fame rests. It is the quality, the originality, and the diversity of the work that are its outstanding features. Throughout it all runs the golden thread of acute observation. He knew his plants personally. As a boy he absorbed specific knowledge almost unconsciously in his father's house, in the Botanic Garden, and in the country round Glasgow. As a young man he travelled the world over to see plants in their native surroundings. As a veteran he lived among them in the great garden at Kew.

In his address as President of the British Association at Norwich in 1868, he gives an insight into his early attitude of enquiry into biological questions. "Having myself," he says, "been a student of Moral Philosophy in a northern University, I entered on my scientific career full of hope that Metaphysics would prove a useful mentor, if not a guide in Science. I soon found, however, that it availed me nothing, and I long ago arrived at the conclusion so well put by Agassiz, when he says, 'We trust that the time is not distant when it will be universally understood that the battle of the evidences will have to be fought on the field of Physical Science, and not on that of the Metaphysical'." This was the difficult lesson of the period when evolution was born. Hooker learned the lesson early. He cleared his mental outlook from all preconceptions, and worked down to the bed-rock of objective fact. Thus he was free to use his vast and detailed knowledge in advancing along the lines of induction alone towards sound generalisations. These had for the most part a very close relation to questions of the mutability of species. The subject was approached by him through the study of geographical distribution, in which, as we have seen, he had at an early age become the leading authority.

Hooker was not, however, merely a botanist. His

interest extended into kindred spheres. He shared with Darwin that wider outlook upon the field of Science that gave a special value to the writings of both. His topographical work in Sikkim would have given him a place as a geographer. His observations of the effects of denudation in the Himalaya, and on the deep-sea deposits in the Antarctic, would have given him a footing as a geologist. But these were only side issues, and it is the purely botanical writings that made him famous. They fall naturally into three groups according to their subjects: the Floristic and Systematic: the Morphological: and the Philosophical. In the first of these, the Antarctic flora and the flora of British India will always form the basis of the study of plants in those widespread regions. In point of richness and variety, as well as of importance to the great population that it sustains, the Indian flora takes rank second to none. The Antarctic flora is a curious contrast to it. Strangely uniform, more and more exiguous the more southerly the latitude, it is scattered over a still wider sector of the earth's surface, where its increasing poverty must always keep human population in check. One who had studied in detail floras so diverse was fitted to survey the world's vegetation, as Hooker did. That his methods were essentially those of the most rigid systematist is shown by the share which he took in two purely technical works of the first magnitude: the *Genera Plantarum*, and the *Index Kewensis*. Both works mark a period in the systematic treatment of plants. Each is up to its date a codification of accurate knowledge, the one of genera, the other of species.

In contrast to these greater works are the Morphological Memoirs, the aim of which is to obtain exhaustive knowledge of the structure and development of certain species or genera. The monograph on *Welwitschia* showed that in this field also Hooker was a master, assigning with accuracy the systematic position of a most

problematical plant. But such work, however successful, was for him an incident rather than a constant preoccupation.

From these sources, and especially from that general conspectus of the vegetable kingdom which he was able with his command of fact to take, Hooker extracted certain generalisations laid down in his Philosophical Essays and Addresses. They related particularly to geographical distribution, and the mutability of species. The method was purely inductive, as is fully shown between the lines of his correspondence with Darwin. So closely parallel and so synchronously did the reasoning of these two friends run, that it became a difficult question to apportion the exact part that each took. Lyell was inclined to give Hooker large credit for his services to the Darwinian theory. Darwin himself says "You will never convince me that I do not owe you *ten* times as much as you can owe me". But this Hooker will not allow. Writing to Darwin on the point that "Lyell seems to think me entitled to a goodly share of the credit of *establishing* though not *originating*" the species-theory, he advances various objections against "putting me in the same category with you as propounder of the Doctrine". It is true that the line of argument in the introduction to the Tasmanian flora, in which mutability of species was upheld, was actually published before the *Origin of Species*, and Lyell gave weight to the fact. But in this friendly contention the letter of January 1844, in which Darwin confides to Hooker the germ of the Theory of Descent, would appear decisive. The world accepts Darwin as the originator of the Species-Theory: and it now knows from the published correspondence how closely the two friends co-operated in its establishment upon a wide basis of fact.

The work of such men as Darwin and Hooker has altered the intellectual outlook for all thinking people, while for the systematist natural affinity now becomes

intelligible. There are doubtless those who, while they must concede the vital nature of the change, may still feel that in so far as the work of these great men dealt with material things, their achievements stand upon a lower plane than those attained in the purer realms of abstract thought. Such views spring from imperfect knowledge of what is required for the highest success in Science: from a want of appreciation of the romance, the adventure, the risks of a voyage into the region of unknown realities; of the precautions, the careful and disciplined thought, and the rigid self-criticism which are the pilots that bring such voyages to a successful close. Moreover, it is not always realised that those very methods of thought, which any scientific man must use, are essentially the same as those which lead to success in the more abstract regions of intellectuality. The difference is that the practical sciences deal primarily with real and tangible things. But any one who follows the work of such men as Darwin and Hooker must feel how tenuous is the line of limitation between morphological reality and morphological abstraction: between the unit observed and the summation of such units into a progression: between the static and the dynamic study of living things. It was this line that was crossed by Darwin: and Hooker was the first of his friends to follow. In him we see the foremost student of the broader aspects of plant-life at the time when evolutionary belief was nascent. His influence at that stirring period, though quiet, was far-reaching and deep. His work was both critical and constructive. His wide knowledge, his keen insight, and his fearless judgment were invaluable in advancing that intellectual revolution which found its pivot in the mutability of species. The share which he took in promoting it was second only to that of his life-long friend, Charles Darwin.

When we review these varied activities, extending throughout the long life of Sir Joseph Hooker, it is not

difficult to account for the pre-eminent position which he held among his contemporaries. This estimate will be an enduring one. For the quality and extent of the systematic work is such that its effect must be felt wherever plants are defined and classified. On the other hand, the originality of the generalisations on Geographical Distribution, and on the Species-Question, has lifted current opinion into new channels, and so altered it that his place in the history of human thought is for ever assured.

DATES RELATING TO THE OFFICIAL AND SCIENTIFIC LIFE OF SIR JOSEPH HOOKER

C.B. 1869, K.C.S.I. 1877, G.C.S.I. 1897, O.M. 1907, M.D., D.C.L., L.L.D., F.R.S., F.L.S.

Born, Halesworth, Suffolk	June 30, 1817
First publication (Hook, Ic. Pl. Vol. II.)	1837
Graduation. M.D. Glasgow University	1839
Sailed for Antarctic	Sept. 1839
First met Darwin	1839
Return of Ross's Expedition from Antarctic	Sept. 1843
Correspondence with Darwin opened	1843
Assistant to Prof. Graham, Edinburgh	1843-1845
Publication of Antarctic Flora	1843-1860
Letter from Darwin on species-question	Jan. 1844
Botanist to Geol. Survey	1846
Fellow of Royal Society	1847
Sailed for India	Nov. 1847
Returned from India	1851
Royal Medal	1854
Himalayan Journals published	1854
Assistant Director of Kew	May 1855
Flora Indica (not completed)	1855
Darwin-Wallace joint communication to the Linnæan Society	July 1858
Introduction to Flora of Tasmania	Nov. 1859
Origin of Species	Nov. 1859
Visit to Syria and Palestine	1860
Welwitschia	1863
Director of Kew	1865
Genera Plantarum	1865-1883
Students' Flora of the British Islands (1st Ed.)	1870
Journey to the Atlas	1871
Flora of British India	1872-1897
President Royal Society	1873-1878
Visit to Rocky Mountains and California	1877
Retired from Directorship	1885
Copley Medal	1887
Darwin Medal	1892
Index Kewensis	1893-1895
Ceylon Flora	1898-1900
Imperial Gazetteer of India (Botany)	1904
Darwin-Wallace Celebration, Linnæan Society	1908
Centenary of Darwin's Birth at Cambridge	1909
Last publication (Curtis' Bot. Mag. t. 8396)	1911
Death	Dec. 10, 1911
Buried at Kew	Dec. 17, 1911

PORTRAITS.

Aged 32 (1849). From a sketch by Wm. Taylor. Life. Vol. I., p. 340.

Aged 38 (1855). From drawing by Richmond. Frontispiece to Life. Vol. I.

Bentham and Hooker together (1870). Life. Vol. II., p. 14.

Linnæan Society's Portrait, by Herkomer (1889). Reproduced as Frontispiece of Life. Vol. II.

Medallion in Bronze, designed for medal in celebration of his 80th birthday (1898). By Bowcher.

Photograph. By Messrs. Russell & Sons, with Lady Hooker (1911), taken at the Camp, Staines.

Wedgwood Medallion.

Medallions. By Bowcher, in Kew Church and in Westminster Abbey.

The above are selected as giving good representations of Sir Joseph Hooker at various periods. The Medallion by Bowcher, prepared for the subscribers to the medal presented on his 80th birthday, has been regarded as a very faithful representation of him at that time.

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